ZERO BEAT
HAMPDEN COUNTY RADIO ASSOCIATION, INC.

Springfield, Mass. ARRL Affiliated, 31st Year March, 1981

## NOMINATING COMMITTEE

Have you ever felt that the club is run by a clique and that you are excluded from things unless you were part of that select group? Well, there is a clique in the club and you should be part of it!!!

The nominating committee is starting the perennial chore of seeking out those people who are willing to help run the club.They are asking club members who are willing to serve the club to come forward and say so! Each year the committee is charged with the responsibility of finding members who are willing to give a little time each month to help run the club as president,vice president,treasurer,secretary as well as directors and Zero Beat staff. The nominating committee would also be happy to hear that you were willing to serve as a member of the coffee bar, a band captain for field day,an instructor for either novice or general classes or program chairman for a meeting. Y O U C A N B E P A R T O F T H E C L I Q U E !!

PLEASE CALL PAUL WA1ZKT, at (413) 568-8291 if you are ready and willing to be part of the crowd

REMEMBER: There is a part you can play, its up to you !!

## PRESIDENT'S CORNER

Who are these people? Do they know I exist? Will they talk to me? Do they know if I'm a visitor or a new club member?

Do these questions bring back memories of a few months, years or decades ago when you were new to the club and amateur radio? Well I'm sure in most cases these memories were reality at some point in time. For this reason the board of directors has decided to re-implement an old but very worthwhile procedure.

At the next club meeting on March 6 we will institute a very quick roll call prior to the address from the featured speaker. This will give the new and/or prospective members an introduction to the members at the meeting.

In addition, if you are a new member or visitor and would like to meet the members and find out more about your club, please contact me (WB1ETS) or one of the other board members working behind the counter in the kitchen. We will be glad to help you out in any way we can.

So members "reach out and touch someone"; make a new member feel welcome at the meeting.

73,

Ron WB1ETS

## FIELD DAY QUESTIONS

In response to questions, this article is appearing sooner than you'd normally see it. Hampden County Radio Association organizes field day in its' own way. In previous years, three people did everything to put us on the air. It was unfair to expect so much from so few and they quit. Now the club organizes field day like this: Two people are appointed chairmen by the Board of Directors. This year it's K1BE and WA1ZKT. The board will decide soon which field day site we'll be at. The chairmen organize the club efforts. Band captains volunteer to take 80, 40, 20, 15, or 10 meters, and are responsible for putting a station on the air on that band. You can be a band captain for say 40 meters, both cw and SSB, or just on one mode. First come, first served, see K1BE.

The chairmen have to put up the signs directing people to the site, bring the logs, checksheets, and first aid kits. It's intended that the band captains have great leeway in what they do. But if a dispute arises, the chairmen have the final say. For example, suppose the cw and SSB stations on 40 were interfering with each other, rather than have the band captains squabble, the chairmen would have to decide what to do.

You can volunteer to help on specific bands by seeing the band captains. (will be listed in a future Zero Beat) Last year we had people who didn't know they could operate other bands because"I'd signed up with so-and-so". Let the chairmen know that you're interested and we'll try to find you more operating time.

What kind of help do the band captains need? You could raise antennas, keep either the regular or "dupe sheet" logs, operate, make coffee, help take it all apart at the end, etc, etc. If you're new to ham radio, it's a great chance to see many different rigs and see how they operate. Plans now include a novice station, so you will be able to operate on the novice bands. Will there be novices there to man it? Let WA1ZKT know! Emphasis this year will be on cw operation, so we hope all our cw people will stop by to operate.

Field Day '81 for Hampden County Radio Association is intended to be a fun weekend with ham radio. The family can stop by and enjoy themselves. Maybe we can have a hot dog and marshmellow roast Saturday night? The club tries to make room for everybody. If a band captain chooses to go "whole hog", that's FB. Or if he wants to set up a two watt rig into a CB whip, that's ok. The idea is to get our equipment out into the boonies and operate! Any other questions, let us know.

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## TIDBITS

WB1HIH in October CD party for WM...WA1YOG now KB1Y, that means there's a KB1E out there too!...The FCC will have other major rewrites, like power levels defined by PEP... Art, W1KK, received a certificate for participation in WMEN from W1UPH...K1MAL must sure make the grandchildren wonder when he and the grandma pull up on his motorcycle...W1KZS is moving... W1UPH now has OES standing... K1COW operating as VP2V on vacation...How about a few more articles from other club members? At least send in a postcard to "TIDBITS" so we know what you've been doing! Who has QST going back far enough to look up the rest of these scores?

SOME PAST HCRA SCORES IN THE JANUARY VHF SWEEPSTAKES:

| Year | Score | Place | Number of Operators |
|---|---|---|---|
| 1975 | 35,394 | 7th | 11 |
| 1976 | 42,771 | 8th | 10 |
| 1977 | 32,570 | 8th | 22 |
| 1978 | 13,358 | 15th | 13 |
| 1979 | 93,570 | 5th | 28 |
| 1980 | 142,566 | 3rd | 25 |
| 1981 | ????? | ?? | ?? |

## VHF SWEEPSTAKES!

Ah, another come and gone! The boredom of working everyone on the band and suddenly, an opening to the West. Sleepily calling "CQ" ' til rare DX appears; Rhode Island! Wondering if people DO live in Vermont? The pileups on .52 when a "virgin" appears late in the contest...Such was the VHF Sweepstakes '81!

Good to find out the Provin Mtn Club had organized an effort. That helped to get everyone's score up. Surprising number of HCRA old timers on this year. Our score won't be official until June QST but looks good. Many thanks to all that helped in big and small ways.

Ideas for VHF SS 1982 are already being discussed. The best one might be to send out DX-peditions to help cover other states. W1QWJ already gives us New Hampshire, and maybe N1AAX could be talked into going to Vermont again. Perhaps we could find another member to go to Rhode Island. Their scores could still count for the club as long as they stay within 175 miles. Multi-op efforts always do well because they're on for most of the contest. Maybe we should organize some of the multi-op efforts to get up on some of the high spots locally, similar to what W1NY did. The old W1QWJ operation from Wilbraham mountain always turned in high scores. They also used to use Barney Estate in Forest Park. What do you think, is it worth considering?

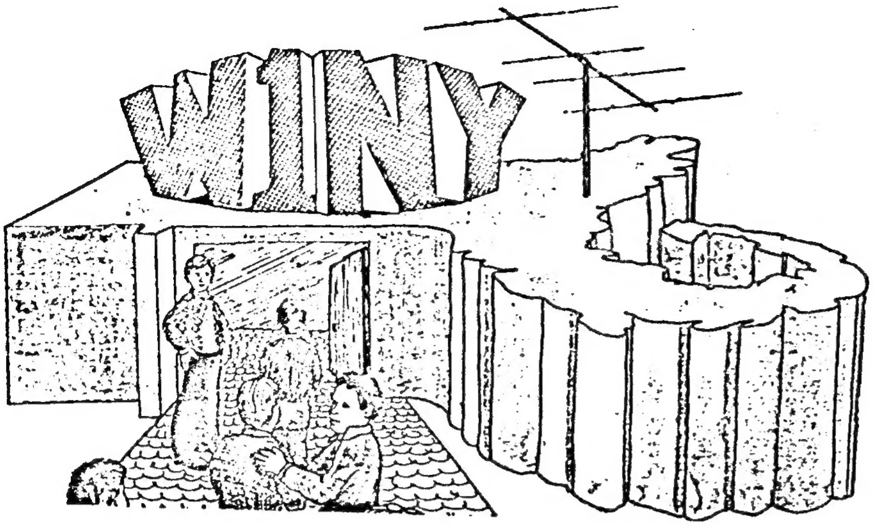
Special thanks to WB1GLZ, et al who put our club station, W1NY on the air for the contest. This was organized at the last minute, and they did a great job.

One last note: What are the old timers talking about when they say "Benton Harbor lunch boxes"?

## COMMENT by K1BE

Hampden County Radio Association is a successful radio club because it is run for the benefit of the members. Every functioning organization needs initiators who'll get the ball rolling. But it's important to know that initiators get "burnt up" in any chemical reaction. Your club's functions require many different people helping in big and mostly small ways. The QSL bureau, Board of Directors, meeting programs, contests, serving coffee and donuts, Field Day, etc etc, all require help to get accomplished. The membership list has not been purged for about six months. Deadwood has to be burnt because the club operates on too thin of a budget. Volunteer help can't be expected to personally pay all expenses. The membership dues will cover the basic expenses but all the little extras that make a club interesting are paid for by raffles, the auction, (a bomb this year!) the May flea market, and the coffee-donut fund. The club needs the continuous support of all its' members. It's very difficult to carry even 10% somnolent membership.

Field Day '81 is organized like all club projects: a lot of people each doing a little. But if we go back to Camp Barber, a great site, the treasury probably can't pay the rent. We'll have to take up a collection. (Some clubs pay for coffee, donuts, and food on Field Day! Golly, to be so rich!) Zero Beat, unlike most club newsletters, does not harp on money every issue. Quality takes time, effort and money! Let's keep the good work going forward by each of us doing a little bit for the commonweal.

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The Hampden County Radio Association, Inc is a non-profit corporation of radio amateurs interested in the investigation of the technical aspects of the communication arts. The club is the base for the first district QSL bureau. We are affiliated with the American Radio Relay League and endorse their programs. The HCRA is a general interest radio club and does not operate any amateur repeaters. The club participates in VHF Sweepstakes in January and Field Day in June. Meetings are held the first Friday of every month, (except July and August) and annual auctions, flea markets, banquets, and general interest programs make up the schedule. The association participates in many different programs and almost every operating event listed in "QST" has at least one member's call. The club station is "W1NY" and is in memory of Hank Baier. "Zero Beat", our club newsletter, is sent out ten times a year to all members.
If you'd like to join us and be an active member, we welcome you. Dues are $7.00 for twelve months and should be sent to Greg Stoddard, N1AEH, 15 Chestnut Circle, West Suffield, Ct 06093.

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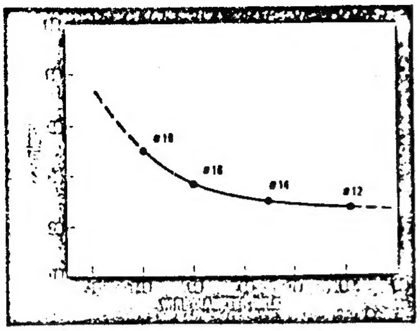
# Hampden County Radio Association




**4. Experimental data.** Characteristic impedance $Z_o$ is plotted for closely wound coils of the size of wire used in power applications. Twisting the wires together decreases $Z_o$ slightly; reducing the spacing between adjacent pairs lowers $Z_o$ as much as 40%.

further, it is possible to show that single-core transmission-line transformers can be constructed with integer impedance ratios of other than 4:1 and even with non-integer impedance ratios—in other words, with fractional impedance ratios.

Figure 3 presents the model for the extended analysis, which employs the same sort of loop equations as before. In this case, three windings are used, instead of two, and the associated voltages $V_1$, $V_2$, and $V_3$ are summed across the load. Conventional transmission-line equations determine $V_2$ with respect to $V_1$, as well as $V_3$ with respect to $V_2$. Output voltage $V_O$ is determined from two transmission lines of equal lengths, not from one transmission line of twice the length. The voltages simply add when transmission lines are short—$V_O$ is three times larger than the input voltage $V_1$, and $I_1$ is twice as large as $I_2$, complying with the principle of the conservation of energy. Also, the flux from the bottom winding tends to cancel the flux from the other two, minimizing core losses. The result is an impedance transformation ratio of 9:1.

### Obtaining fractional ratios

Impedance ratios of other than 9 or 4 to 1 become possible if the top winding is tapped. Since all windings are tightly coupled electrically, a common voltage gradient of $V_1$ exists from left to right along the windings, and the voltage at the tap, terminal 7, becomes $V_O = V_1 + V_2 + V_4$. Now $V_1 = V_2$, and $V_4 = (l/L)V_1$, where L is the length of the transmission line and l the length to the tap. Consequently:

$$V_O = V_1(2+l/L)$$

To generalize this equation, let n = the number of windings below the top winding which is tapped so that:

$$V_O = V_1(n+l/L)$$

Rod-core transformers allow for fractional turns, so their l can have any value up to L. But for toroidal-core transformers, which do not allow fractional turns, the equation becomes:

$$V_O = V_1(n+n_t/N)$$

where $n_t$ equals the number of tapped integer turns and where N equals the total number of integer turns.

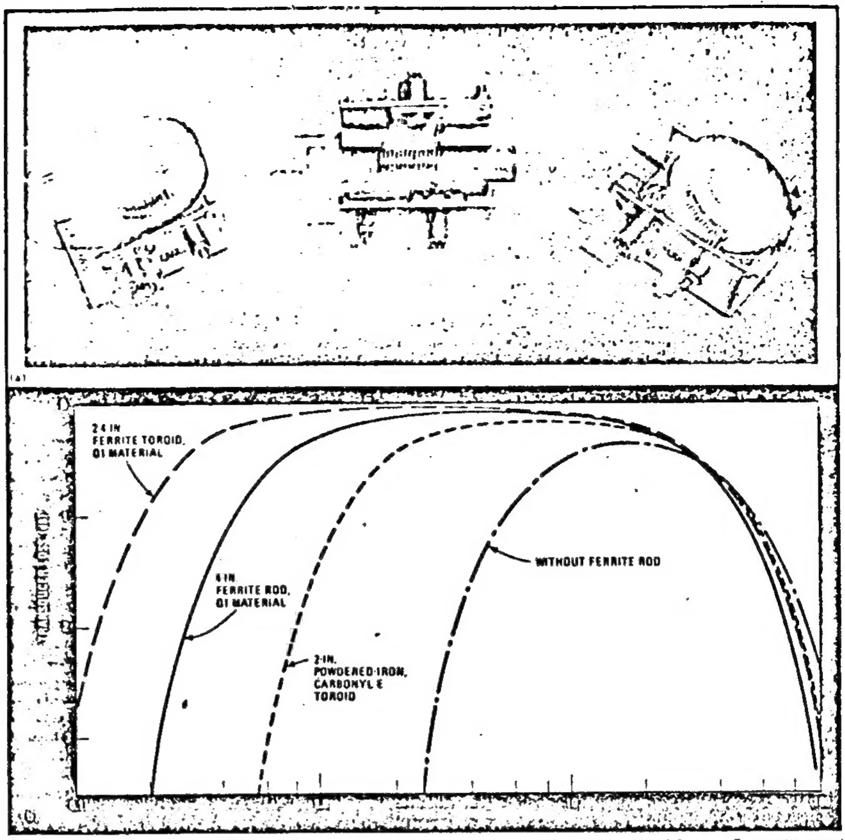
Simply tapping off the top winding of the two-winding 4:1 transformer shown in Fig. 2 makes n equal 1, so that ratios of less than 4:1 become possible.

Since the output voltage depends on the length ratio or turns ratio, it is easy to design a matching transformer for a particular impedance. For example, to match a 50-ohm coaxial cable to a 35-ohm self-resonant vertical antenna, the impedance ratio must be 50/35 or 1.43. Since the voltage ratio is proportional to the square root of the impedance ratio, $V_O/V_1 = (1.43)^{1/2} = 1.2$. Then the value of l/L can be found from the general equation for a bifilar-wound rod-core transformer:

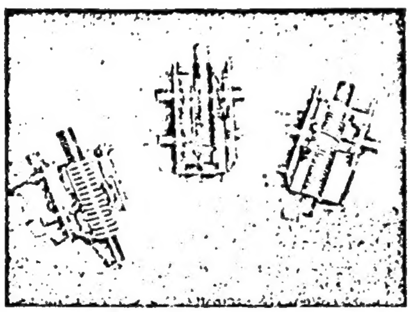
$$V_O/V_1 = n + (l/L)$$
$$1.2 = 1 + (l/L)$$
$$l/L = 0.2$$

Thus, the two-winding network with a rod core will require a tap at 0.2 of its length from terminal 3 of Fig. 2. For a toroidal-core transformer, tapping 2 out of 5 turns, or 4 out of 10, would give a similar result.

Besides the two basic equations (1) and (2), three parameters are needed to design broadband transformers. They are: characteristic impedance $Z_o$, which depends on the number of turns and the shape and spacing of the windings; the shunting inductance that affects low-frequency rolloff and itself depends on the size and type of core material; and the effective phase constant of the coiled transmission line, which determines the transformer's high-frequency response and depends on the dielectric of the wire insulation and coupling between windings.




**5. Comparing response curves.** All transformers provide a 4:1 impedance ratio to match 50 ohms to 12.5 ohms. The tightly wound transmission-line windings use 14-gauge enameled wire on cores that employ different materials and geometries (solenoidal or toroidal).



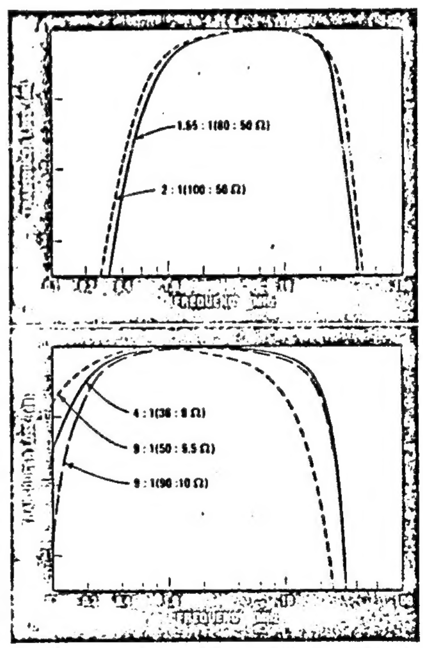
**6. Varying the impedance ratio.** Two-winding step-up transmission-line transformers provide a 1.55:1 ratio (left) and a 2:1 ratio (right), while a three-winding transformer (middle) can provide either a 9:1 or 4:1 ratio. All three devices were wound with 14-gauge enameled wire on ½-inch-diameter, 4-inch-long ferrite rods. The frequency response of each of the transformers is plotted in Fig. 7.

As already noted, the optimum value for the characteristic impedance of the transmission line of a 4:1 matching transformer is the geometric mean of the input and output resistance, $Z_o = (R_gR_L)^{1/2}$. Initial results for fractional-ratio designs indicate that for them, too, the optimum values of $Z_o$ are the geometric means of their input and output resistances. It has been found that generally, with characteristic impedances of twice or half the optimum value, the transducer loss is less than 0.2 dB with short transmission lines of 0.09 λ or less.[2] The author found experimentally that little degradation is observed at the high-frequency cutoff with departures as large as 10% from the optimum value of $Z_o$. The characteristic impedance, however, does vary with frequency because the permeability of the core material is frequency-sensitive. Usually the optimum value of $Z_o$ should be determined at the highest frequency of operation.

To lower the characteristic impedance, should that be necessary, transmission lines can be twisted together. Twisting them lowers $Z_o$ by increasing their distributed capacitance. A more significant change, however, can be made by just tightly coiling the transmission lines and so minimizing spacing between windings.

### How to adjust $Z_o$

Figure 4 shows experimental data for various tightly wound, bifilar coils of typical wire sizes used in power step-down applications. For instance, $Z_o$ can be lowered about 40% by reducing the spacing between adjacent pairs of wires from three wire-diameters to that of the insulation of the wires.




**7. Plotting response.** The characteristic impedance is optimum for the 4:1 transformer but for the 9:1 transformer only when matching 90 to 10 ohms, not 50 to 5.5 ohms. For the latter case this less-than-optimum impedance causes a more rapid falloff at high frequencies, but, since an inductive reactance of only 5.5 ohms, not 10 ohms, has to be exceeded, the low-frequency end is improved.

For step-up transformers to maintain high-frequency performance, however, larger winding separations are necessary. This can be done by separating the turns with extra insulation, such as Teflon tubing, to increase the characteristic impedance. For example, tightly wound turns, separated by Teflon sleeving, approach a $Z_o$ of 70 ohms and are useful in step-up transformers that must match 50 ohms or more.

### The core's role

Shunting inductance varies with the geometry and permeability of the transformer's core material. To define the core role more closely, three 4:1 matching transformers were tested (Fig. 5). Two used toroidal cores, and one used a solenoid. One toroid was of Q1 ferrite material with an outer diameter of 2.4 in. and a thickness of ½ in. The other toroid was powdered iron (Carbonyl E, $\mu$ = 10 nominally) with an outer diameter of 2 in. and a thickness of a little less than ½ in. The solenoid was a rod of ferrite material, ½ in. in diameter and 4 in. long. (Various lengths of rod were tried, but

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# Broadband matching transformers can handle many kilowatts

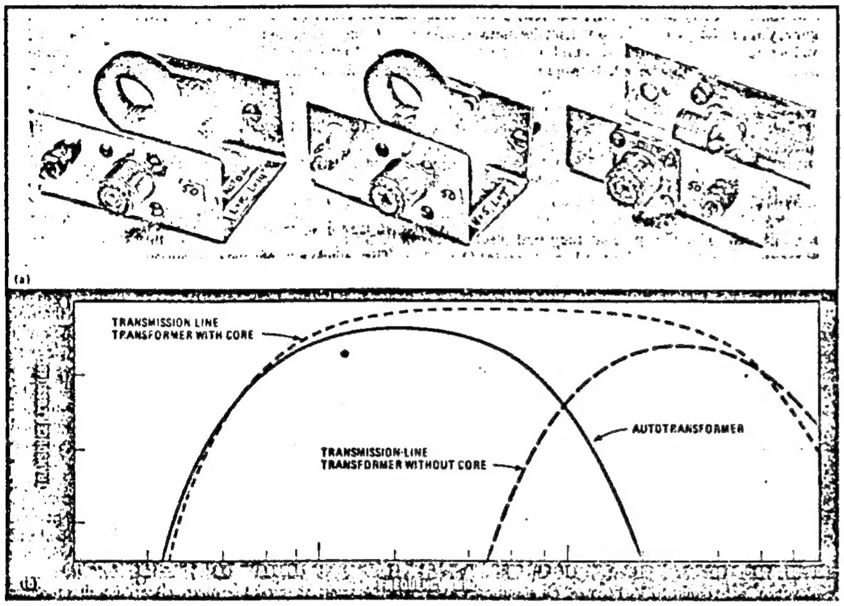
**The discovery that transformers with transmission-line windings have 98% efficiencies opens up new uses for them in high-power applications**

by Jerry Sevick, Bell Laboratories, Murray Hill, N.J.

☐ The big news about broadband matching transmission-line transformers is their ability to deal with many kilowatts of power. On investigation, their efficiency turns out to be much higher than anyone had suspected—an astonishing 98% over most of a frequency range spanning several hundred kilohertz to 100 megahertz. Also news is the fact that they can be built with fractional impedance transformation ratios.

The small rugged devices, made of a short length of transmission line coiled around a single magnetic core, are in wide use because of their inherently large bandwidth. Now their applications should be extended in particular to matching high-power amplifiers to an antenna, as well as matching small-signal amplifiers.

Experience long ago showed that other broadband matching devices—whether networks of capacitors and inductors or conventional transformers—had smaller bandwidths and lower efficiencies. High ohmic loss characterizes inductors of the size needed at low frequencies. High core loss in conventional transformers drastically reduces their efficiency and with it their power-handling capability.




**1. No magnetic coupling.** The curves plotted for three types of transformers show that the transmission-line type with a toroidal core has good efficiency even at the very-low-frequency end, proving that there is considerable energy transferred by the transmission-line mode. At higher frequencies the core provides increased efficiency and bandwidth by preventing unwanted shunting currents.

But only recently have careful experiments been done to determine just why a broadband transmission-line transformer is so superior. The new data explodes several assumptions about its mode of operation and about the function of the core.

In particular, the device was always thought to behave quite differently at the low and high ends of its frequency range. It was supposed to act like a conventional, three-terminal autotransformer at lower frequencies, coupling energy magnetically through the core, but like a transmission line at high frequencies, with the core having little effect.

### What really happens . . .

Accurate measurements suggest another explanation. The transmission-line mode seems to be in effect throughout the frequency range, except at the very lowest end. The core's role is to prevent shunting currents at all frequencies and never to couple energy, except at the very lowest end of the range.

The equal and opposite currents that flow in the transmission-line windings essentially cancel core flux and so minimize core loss. The shortness of the transmission line (in relation to the wavelength of the highest operating frequency) minimizes ohmic losses, keeping output voltage nearly equal to input voltage over a wide frequency range so that a constant transformation ratio is maintained. Coiling the line around a magnetic core provides the inductance needed to prevent unwanted currents from flowing, except at very low frequencies.

Three transformers with 4:1 impedance ratios were constructed, and their performance was measured under similar conditions (Fig. 1). One was a conventional autotransformer of 10 turns on a toroidal core. The other two were transmission-line transformers of 10 turns with and without the core. The toroidal cores had an outer diameter of 1.25 inches, an inner diameter of 0.75 in., and a thickness of 0.375 in., and they both used high-bulk-resistivity ferrite material (Indiana General Q1).

As the plot of transducer loss versus frequency shows, the transmission-line transformer with a core acts just like a conventional autotransformer at very low frequencies. At about 400 kHz transmission-line operation starts contributing to its efficiency, and through 40 MHz it suffers much less than the autotransformer from transducer loss, suggesting reduced core loss. But without a magnetic core to choke off shunting currents, not only is its efficiency much less, but its frequency response also falls off rapidly below 1.5 MHz.

### . . . and why

Figure 2 presents a model for the most widely used 4:1 unbalanced-to-unbalanced broadband transmission-line transformer. As can be seen from this model, if the line is half a wavelength long, $V_2$ equals $-V_1$, and the output power is zero. But for much shorter transmission lines, $V_2$ is very nearly equal to $V_1$ because no standing waves exist. Then—provided that nothing much more than transmission-line current is flowing through the bottom winding—the output voltage is twice the input voltage, the output current is half the input current, and a 4:1 impedance transformation exists.

The relationship holds up quite well if the transmission line is shorter than 0.2 of the effective wavelength. At this length the mismatch corresponds to a voltage standing-wave ratio of 2:1 where the transducer loss increases by 0.4 decibel. Any longer, and the VSWR of the particular length will increase or decrease $V_2$, and the transformer will become less useful.

### Two basic equations

The efficiency of such a transformer depends on different factors at high and low frequencies. The voltage standing-wave ratio is critical at the high end, and the reactance of the bottom winding to any shunting current present, though important throughout the range, becomes especially critical at the low end.

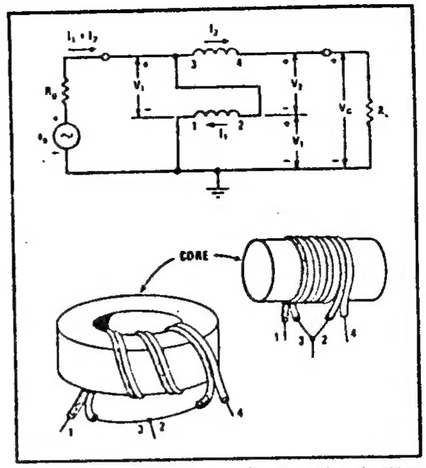
An equation for high-frequency transducer loss can be derived from the model in Fig. 2 if loop equations are applied to it, as Ruthroff has shown.[1] When $I_1$ is assumed equal to $I_2$, the result is:

$$\frac{\text{available power}}{\text{output power}} = \frac{(1+3\cos\beta l)^2 + 4\sin^2\beta l}{4(1+\cos\beta l)^2} \qquad (1)$$

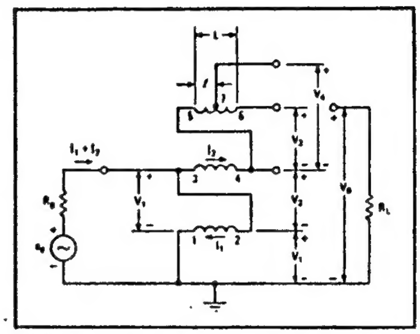
where $\beta = 2\pi/\lambda$[illegible] and l is the length of the transmission line.

The equation is the reduction of a more general one, from which it is obtained by insertion of the optimum value for the characteristic impedance, $Z_0$. This value is the same as that of the quarter-wavelength matching transmission line, namely the geometric mean of the source and load resistance, $(R_gR_L)$."

Note that no reference to a core of magnetic material is contained in this analysis. In the transmission-line mode, the magnetic fields cancel at high frequencies, so that almost no flux threads the core.




**2. Transmission-line transformer.** Both toroidal- and rod-type transformers provide broadband operation. Shown is the popular 4:1 unbalanced-to-unbalanced transformer that uses two wires of equal diameter closely wound around a magnetic core material.



**3. Other ratios.** A 4:1 impedance ratio results when the transmission-line transformer's output is connected between ground and terminal 4, 9:1 when it is connected between ground and terminal 6. Tapping off the top winding (terminal 7) yields non-integer ratios.

However, the core's effect needs stating at low frequencies. At this end of the range, the transformer's response is determined mainly by the reactance of the bottom winding to the flow of a shunting current. If the reactance is made large enough, only transmission-line current will flow, and the impedance transformation ratio will be maintained.

One way to increase reactance would be to increase the number of turns of the transmission line, but that would lengthen it and so degrade its high-frequency performance. The preferred way is to use high-permeability core material, particularly in the case of a toroidal configuration.

The model for the low-frequency region can then be represented by an inductance in parallel with an ideal transformer. In mathematical terms:

$$\frac{\text{available power}}{\text{output power}} = \frac{R_g^2 + 4X^2}{4X^2} \qquad (2)$$

where X is the reactance of the bottom winding with the secondary open-circuited.

### A different mechanism

Although this equation is identical to that for the low-frequency response of the conventional transformer, the modes of operation are different. The transmission-line transformer, for as long as it is transferring considerable quantities of power at low frequencies, is still acting like a transmission line and not like a conventional transformer, which transfers power entirely by the common flux linkage. But it may start acting as an autotransformer at still lower frequencies if it experiences appreciable core flux and the choking action is inadequate to prevent the generation of excessive currents in the bottom winding.

The analysis of the transmission-line transformer's operation need not stop here. If it is carried a step

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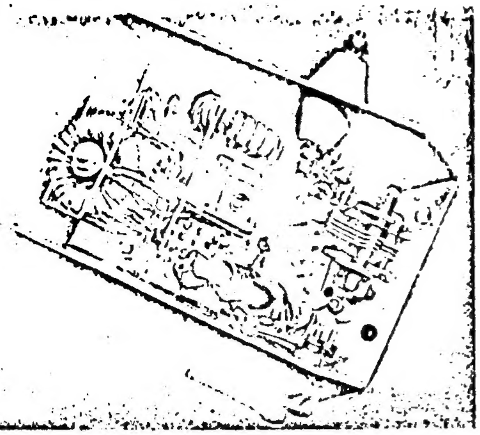

**8. Antenna matching.** Two transmission-line ferrite-rod transformers match the changing impedance of a 29-ft vertical antenna operating at 1.8, 4, and 7 MHz. The antenna is resonated by powdered-iron toroids at low frequencies, by a variable air capacitor at high ones.

with very similar results—the longest just had a slightly better low-frequency response.)

All transformers were tightly wound with 15 inches of 14-gauge wire to approximate an optimum $Z_0$ of 25 ohms and assure similar high-frequency performance. Inductance measurements at 1 MHz on the low-impedance side of the network, with the output open-circuited, yielded:

| | |
|---|---|
| Ferrite toroid, | $L_{oc}$ = 11.08 μH |
| Powdered-iron toroid, | $L_{oc}$ = 1.67 μH |
| Ferrite rod, 7.5 in. long, | $L_{oc}$ = 6.07 μH |
| Ferrite rod, 4 in. long, | $L_{oc}$ = 4.67 μH |
| Ferrite rod, 2.5 in. long, | $L_{oc}$ = 3.69 μH |
| Ferrite rod, rod removed, | $L_{oc}$ = 0.413 μH |

The low-frequency performance of a toroid is clearly superior to a rod's owing to the former's enclosed reluctance path and hence higher inductance. Because of the much higher value of reluctance in the airpath around the rod, little is gained at the low-frequency end by increasing its permeability. But with a toroid, inductance is proportional to the material's permeability, so that the higher the permeability, the better the low-frequency performance. Note the poor performance of the powdered-iron toroid with its lower permeability.

Finally, to ensure that these transformers were free of nonlinear or amplitude effects, they were subjected to various power levels. Invariably no additional power loss was discernible at levels up to 1 kw.

### The design potential

The transformers with ferrite cores covered a rather wide frequency range with losses of only about 0.05 dB. Since this loss is a combination of mismatch and transformer losses, efficiencies were greater than 98% over that range. Few networks can compete with such high efficiencies, which allow these transmission-line transformers to be cascaded to obtain higher impedance transformation ratios.

The major difficulty, however, is in getting the proper value of characteristic impedance for large step-down or step-up impedance ratios. For step-down a low value is needed, whereas step-up requires a higher value.

Generally, for very low values of characteristic impedance, stripline techniques are used. However, for higher values of $Z_0$, the transmission lines must be separated. This is easily done. The use of Teflon or other insulating materials between windings provides known and controllable spacing.

These transmission-line transformers provide typically wideband performance even when tapped to provide a variety of impedance transformation ratios. This is not achievable with conventional transformers that use flux linkage as the energy-coupling method.

Figure 6 shows two transformers with other than 4:1 ratios, along with a transformer of three windings on a rod connected in a 4:1 and 9:1 fashion. The transformer on the left is tapped for a 1.55:1 impedance transformation, while the one on the right is a 2:1 step-up.

All were designed for operation with 50-ohm coaxial cable, and their loss versus frequency is plotted in Fig. 7. Even using rod-type cores, these transformers exhibited rather wide frequency response. Of course, the bandwidth could be further increased if a toroidal core were used. But unless the extra bandwidth is necessary, it does not pay to use the more expensive toroid.

One difference is worth noting. The 1.55:1 and 2:1 transformers performed similarly whether matching 50 to 5.5 ohms or 90 to 10 ohms. But in the 9:1 transformer, matching between 50 and 5.5 ohms produced better low-frequency performance. The reason is that the inductive reactance of the transformer, although the same in either case, needs only to be greater than 5.5 ohms of inductive reactance instead of 10 ohms. However, when matching to the higher impedance, the upper frequency cutoff was greater since the characteristic impedance of the transformer was equal to the optimum value.

### Cool operation

All transformers were tested at 1-kilowatt operation. As was also the case with the 4:1 transformer, they suffered no discernible power loss or heating. Consequently, these fractional-ratio transformers can be cascaded to provide all sorts of impedance ratios. One instance is the network shown in Fig. 8, which can handle 1 kw of power and uses two transmission-line transformers wound on ferrite rods to match a 50-ohm cable to a 29-foot vertical antenna having a 13-ft top hat at 1.8, 4 and 7 MHz.

The ferrite toroid was not fully looked into and now bears further investigation. The only comparison made was with a single value of permeability, that of Q1 material, which was the first nickel-zinc ferrite used for amplitude-modulated radio antennas, i-f and rf transformers. Toroids with greater permeability look very promising for transmission-line transformers requiring even larger bandwidths at rather high power levels. ❑


References
1. C. L. Ruthroff, "Some Broadband Transformers," Proc. IRE, vol. 47, August 1959, pp. 1337–1342.
2. O. Pitzalis and T. P. Couse, "Practical Design Information for Broadband Transmission Line Transformers," Proc. IEEE, April 1968, pp. 738–739.


Electronics/November 25, 1976

H.C.R.A. Would like to welcome its newest members:

| | |
|---|---|
| WA1GZO | Ted Lockwood |
| KA1CQK | Carl Sittard |
| KA1??? | Barbara Kress |

We would also like to congratulate the areas newest HAMS. All XYL who successfully complete their novice exams.

A special congratulation to KA1GPC 11 year old Claudine Bouchard

FLEA MARKET COMING

MAY 1st,1981

GOOD TIME TO SELL SOME OF THAT SURPLUS EQUIPMENT IN THE ATTIC OR CELLAR.

Massachusetts: The Hampden County Radio Ass'n. Will hold it's annual flea market on May 1, 1981 at the Feeding Hills Congregational Church, intersection of routes 57 and 187, Feeding Hills, Mass. Amateur and electronic equipment will be sold. Doors open at 7:00 pm. Admission will be free and sellers tables will be $3.00 each. For more information call André Bouchard WB1BZW 413-786-9735. Talk-in on 146.52 Mhz.

FOR SALE or trade for ham gear: Integral systems model 10, stereo preamplifier, $100.00 ; TEAC dolby unit for tuner or tape deck, $50.00; BSR stereo graphic equalizer (5 bands per channel) $50.00; DYNACO QD-4 quad matrix adapter (stereo to quad) $10.00; call Bruce Felper, 203-888-7935 or 207 South Main St, Seymour Ct 06483

MEETING NOTICE

NEXT MEETING WILL BE FRIDAY MARCH 6,1981
AT THE FEEDING HILLS CONGREGATIONAL CHURCH
CORNER OF ROUTES 57& 187
FEEDING HILLS, MASS.
TIME IS 8 PM

TOPIC: PRACTICAL USE OF TEST EQUIPMENT
SPEAKER : N1CQ Bill Shaheen

APRIL MEETING

TOPIC: FEED LINES AND TUNERS

ART W1KK AND BILL W1TM WILL TALK ABOUT
FEED LINES AND TUNERS WITH EMPHASIS ON
HOME BREW TWIN LEAD

HOPE TO SEE YOU THERE



HAMPDEN COUNTY RADIO ASSOCIATION, INC.
RAY MORIN, KA1CRG , EDITOR
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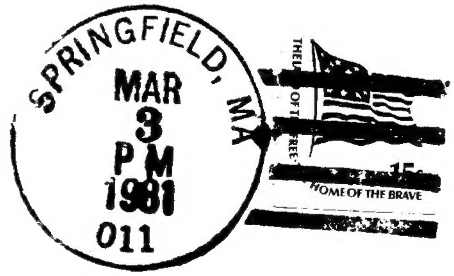


MARCH ZERO BEAT 81

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